444. Campylium chrysophyllum. Moist ground, dead wood, roots of trees, etc., southeast Kansas.

445. Campylium hispidulum Mitten. Ground, dead wood, etc., eastern Kansas. (Rau.)

446. Hypnum aduncum Hedw. var. Damp ground, central Kansas. (Rau.)

447. Hypnum curvifolium Hedw. Dead logs in shady woods, common.

These 447 species of plants in Kansas, added to the 1,355 already published, makes a total of 1,802 plants, not including hepaticæ, fungi, lichens, or algæ. The totals thus far are 1,666 flowering plants, 40 ferns and filicoid plants, and 96 mosses. The largest order by far is the Compositæ, embracing 292 species; next in size is the grasses, comprising 204 species; and following that is the Leguminosæ, consisting of 128 species. Other orders, except the Cyperaceæ, are less than 100. The future may reduce slightly, but will probably increase, these numbers. The work is by no means ended. There is more to come.

EXPERIMENTS IN 1890 FOR THE ARTIFICIAL DISSEMINATION OF CONTAGIOUS DISEASES AMONG CHINCH-BUGS.

BY F. H. SNOW, LAWRENCE.

At the last meeting of this Academy, at Wichita, in October, 1889, the writer presented an account of his experiments in 1889 for the artificial introduction of contagious diseases among chinch-bugs. These experiments have been continued from the date of that meeting up to the present time (November, 1890).

Inasmuch as these maladies of the chinch-bug are not kept alive in the field under ordinary out-of-door conditions of the winter season, the next important point to be gained was their preservation through the winter in the laboratory, in order that they might be under control and be available for use in the season of 1890. To accomplish this result, I placed fresh, healthy bugs in the infection jar late in November, 1889, and was pleased to note that they contracted disease and died in the same way as in the earlier part of the season. I was not able to obtain fresh germs in the spring of 1890 until the month of April, and then only a limited supply of live bugs could be secured. I quote the following from my laboratory notes:

"April 10th, twenty-five chinch-bugs that had hibernated in the field were put in the infection jars. They were supplied with young wheat plants. The bugs appeared lively and healthy.

"April 16th, some of the bugs were dead, and all appeared stupid.

"April 20th, all of the bugs were dead.

"One week later a new supply of fourteen bugs was put into the jar; they were supplied with growing wheat. They ran substantially the same course as the first twenty-five. Some had died at the end of the first week, and all were dead by the end of the thirteenth day."

The chinch-bug seemed to have been very generally exterminated in Kansas in 1889, and only three applications for diseased bugs were received in 1890 up to the middle of July. On account of the limited amount of infection material on hand, I required each applicant to send me a box of live bugs, which I placed in the infection jars, returning in a few days a portion of the sick bugs to the sender. The three applicants above noted reported the complete success of the experiments. I

give the following letter from Mr. M. F. Mattocks, of Wauneta, Chautauqua county, Kansas:

WAUNETA, KANSAS, July 7, 1890.

Prof. Snow, Lawrence, Kansas—DEAR SIR: I received from you a few days since a box of diseased chinch-bugs. I treated them according to instructions, and I have watched them closely and find that they have conveyed the disease almost all over my farm, and the bugs are dying at a rapid rate. I have not found any dead bugs on farms adjoining me. I here inclose you box of healthy bugs that I gathered 1½ miles from my place. I do not think they are diseased. Yours, M. F. MATTOCKS.

I also quote the following clipping from the Cedar Vale (Chautauqua Co.) *Star:*

"INFECTING CHINCH-BUGS.—There is no longer any need of having our crops destroyed by chinch-bugs. A remedy that is as sure as death and which costs nothing has been discovered, and is used in this county with complete success. Mr. M. F. Mattocks, living a mile and a half east of Wauneta, on the H. P. Moser farm, is entitled to the credit of demonstrating, in this part of the State, the efficiency of the remedy. He was about to lose his corn crop by the bugs that were swarming into it from the stubble. He sent to Chancellor F. H. Snow of the State University, at Lawrence, and received from him a box containing a half-dozen diseased bugs. With them he exterminated a forty-acre field full of the pests. They have died by the millions; in fact, they have about all died from the infection of those six bugs. A little circular of instructions, which he followed out, came with them. The six bugs were placed in a bottle with three or four hundred from the field, and were left together thirty-six hours and then turned loose, both the living ones and the dead, in the field. Devastation followed, and Mr. Mattocks will be troubled no more with chinch-bugs this year. If your crop is in danger you can save it by the same means of getting the diseased bugs in your field. It will cost you nothing, and is a dead-sure remedy. He has been sending dead and infected bugs to others in the country, and to Prof. Snow, whose supply was running down."

I personally visited Mr. Mattocks's farm and verified the above statements.

The difficulty of obtaining enough live bugs to experiment with in the laboratory led to the sending out of the following advertisement, which was forwarded to twenty prominent papers, with requests for its publication:

"WANTED! CHINCH-BUGS!—Prof. F. H. Snow, of the University of Kansas, is in great need of some live and healthy chinch-bugs with which to carry on his experiments in chinch-bug infection. Anyone who will send a small lot of bugs to Prof. Snow, University of Kansas, Lawrence, Kansas, will confer a favor on the investigator, and, it is hoped, on the farmers of Kansas."

This request for live bugs was given wide circulation, and resulted in keeping the laboratory fairly well supplied with material for experiment.

Before the close of the season of 1890 it became evident that there were at least three diseases at work in our infection jars: the "white fungus" (*Entomophthora* or *Empusa*), a bacterial disease (*Micrococcus*), and a fungus considered by Dr. Roland Thaxer to be *Isaria*, or perhaps more properly *Trichoderma*.

The following report, which describes the bugs as "collecting in clusters," points to the bacterial disease as the cause of destruction:

PIQUA, WOODSON COUNTY, KANSAS, July 12, 1890.

Prof. Snow, State University, Lawrence, Kansas—DEAR SIR: Since writing you from Humboldt, Kansas, the 6th inst., have made the happy discovery that the germs of contagious disease sent me were vital. On Sunday last, upon examination of the millet field, I found *millions* of *dead bugs*. They were collected in clusters. My idea is that dampness facilitates the spread of the contagion. The first distribution of diseased bugs, two days after I received the package by mail, apparently produced no results. A part of them were retained in the infection jar (quart Mason fruit jar). A half-pint of bugs were collected from the field. Three days later a foul stench was found to emanate from the jar, and a part of the bugs in it were dead. On July 3, I took advantage of the cool, damp evening, and took a few buckets of cold water and sprinkled the edge of the millet, and distributed more infected bugs. On the 6th I found millions of dead bugs. I think the night, and sprinkling the millet, caused the disease to spread. We have had no rain in this neighborhood since June 17, if I remember correctly. The depredations of chinch-bugs are always more serious in dry, hot weather.

You have conferred a lasting benefit on the farming interests of the United States, the value of which cannot be estimated in dollars and cents. It was estimated that, during one of the visitation years of this insect, the damage in the Mississippi valley amounted to ten millions of dollars. I have no doubt that by a proper manipulation of the contagious disease, in the hands of intelligent persons, it will prove an effective remedy. I think the contagion should be introduced among them early, to prevent the migration of the young brood. In my case I received it too late. Early-sown millet pre-

sents a favorable place to infect the bugs, as they seem to collect in the shade and die. Hoping that when the next Legislature meets an appreciating public will suitably reward you for your beneficent discovery, I am, Gratefully yours, J. W. G. McCORMICK.

The field experiments were apparently equally successful in the months of July, August, and September.

The following August field report is inserted as a fair sample of the manner in which the farmers themselves regard these experiments:

FLORENCE, KANSAS, November 1, 1890.

Prof. F. H. Snow—DEAR SIR: On the 20th of August (I think it was) I wrote to you to send me some infected chinch-bugs, and on the 30th of the same month you sent me a small lot of infected bugs (I suppose about thirty in all). I then put with these about twenty times as many healthy ones and kept them forty-eight hours, and then deposited them in and through my field. (I have about fifty-five acres under cultivation.) At the time I wrote for bugs my place was all in corn and a very large crop of chinch-bugs. I am safe in saying that there were more bugs on my farm than any two with the same amount of land under cultivation. At the time of sending to you for bugs I told two of my neighbors of my intention, and they laughed at the idea; nevertheless I sent. When I put them in my field it had rained fully a half-day, and after noon I commenced to place them about in different places in my field. I noticed no change in the bugs for three days, it being cold, and on the fourth and fifth days the weather was more warm, and it was then that the destruction of the enemy commenced, with great satisfaction to myself and great surprise to my laughing neighbors. One of my neighbors, Mr. George Winchester, said that there ought to be a subscription raised and donated to me. I told him not to me, but to you the praise belonged.

I think that it took about eight days after the fifth from the time that I placed them in my field before they were all destroyed. The fifth day after I put out the diseased bugs I noticed that a great many bugs were flying away from my place. I cannot say if the disease spread in this way or not, or if it spread at all. Three or four persons said that they would come and procure of me some of the dead bugs, but no one came.

This much I can say: with me this experiment has been a complete success. It has done me a great deal of good. I cannot give it a money value, but am satisfied that had it not been for the infected bugs obtained of you I would have lost twenty-seven acres of wheat and eight acres of rye, and when I wrote to you for bugs I then contemplated putting out considerable wheat, and I was at that time considerably troubled about the bugs in my corn, thinking that if I put out any wheat at all it would be destroyed by bugs; but, thanks to you, my wheat is now safe from bugs, at least those that were on my place before sowing my wheat. I only wish that I had written to you sooner.

I will send by express one bottle of bugs that I gathered after they commenced to die.

Respectfully, JOHN F. KNOBLE.

The following report from R. L. Staugaard is inserted as being of a more scientifically circumstantial character than most of the other reports:

FLORENCE, KANSAS, August 22, 1890.

Prof. F. H. Snow, Lawrence, Kan.—DEAR SIR: In reply to your favor of July 27, last month, would say, that infected bugs were applied after they were kept with live ones about 42 hours. They were applied as follows:

Most of the bugs mixed were dead when taken out of the box. They were applied in seven different hills, being put into every ninth hill. I marked every hill with a number so as to be better able to watch the progress.

Examined after 48 hours' application, with the following results: No. 1, mostly dead; No. 2, mostly alive—seemingly very restless; No. 3, bugs seem to be sick; No. 4, bugs mostly dead, (on hills around this, bugs seemed restless;) No. 5, not examined, (on hills around it the bugs seemed to be affected.) Examination three days after application with the following results, to wit: No. 3, bugs seemingly in a dying condition, (on the hills around it the bugs seemed to be well with the exception of one hill, where they seemed to be dying, and some dead.) No. 4, not a live bug in the hill; No. 5, apparently dying, also dying in the hills around this; No. 6, bugs dying in the hill; No. 7, apparently not dying.

On August 16th, twelve days after application, I found the bugs to be dying and dead all through the field (12 acres).

On August 20th, I again found the bugs to be dying rapidly. A field being forty rods distant had sure marks of bugs in a dying condition. What I mean by bugs being in a dying condition is this they lay on their backs almost motionless, and others lay in the same position moving limbs violently.

This remedy was applied on A. G. Rosiere's farm, on Bruno creek, Marion county, Kas., being nine miles east and three miles south of Marion.

Thanking you for your favors, I remain, yours truly, R. L. STAUGAARD.

The laboratory experiments have been continued through the season. Of the three diseases identified, that produced by the Trichoderma appears to be less fatal than the other two, as is indicated by the following laboratory notes:

"September 28th, dead chinch-bugs, showing no signs of fungus externally, were taken from the infection jars and crushed on a glass slide in distilled water. Oval hyphal bodies of a fungus (*Trichoderma*) were found in considerable number. These were put under a bell jar.

"September 29th, some of the hyphal bodies had put out slender, mycelial growths; others in immense numbers were multiplying by division.

"October 1st, the hyphal bodies were still multiplying by division. The mycelial growths had become much larger, and in some instances had variously branched.

"October 3d, a dead chinch-bug taken from an infected field was crushed on a glass slide in distilled water. Both round and oval hyphal bodies were found in considerable number. These were put under a bell jar to prevent drying.

"October 4th, both round and oval hyphal bodies were multiplying by division, and were putting out mycelial growths.

"October 5th, fresh chinch-bugs, from an uninfected field, were immersed in the liquid containing the above fungi, and were put in a new jar with young corn plants."

The following is a summary of the results of the field experiments in the season of 1890:

Number of boxes of diseased bugs sent out, thirty-eight. Seven of these lots were either not received, or received and not used. Reports were received from twenty-six of the thirty-one remaining cases. Of these twenty-six reports, three were unfavorable, nineteen favorable, and four doubtful concerning the success of the experiment. These doubtful cases are not to be looked upon as unfavorable, but more evidence is needed to transfer them to the list of favorable reports. These nineteen out of twenty-six reports, or seventy-three per cent., were decidedly favorable. The experiments will be continued during the season of 1891.

In presenting this paper I wish to acknowledge the invaluable aid continually received during the progress of the work from my assistants, Messrs. W. C. Stevens and V. L. Kellogg.

SOME EXPERIMENTAL TESTS OF THE PASTEUR FILTER.

L. E. SAYRE AND V. L. KELLOGG, LAWRENCE.

It is claimed for the Pasteur filter that it perfectly filters water (or other liquids) of, among other impurities, bacteria; that water teeming with disease-producing germs after being filtered by means of this contrivance, is wholly free from their presence. The filter is well known; to the few who may not have seen it, it may be said that an unglazed earthenware cylinder closed at one end is introduced into a metal cistern or jacket, which may be filled with water, or other fluid. The open end of the filter projects from the cistern through a perfectly tight collar. The fluid in the cistern filters through the cylindrical earthenware cup, and is received from its projecting open end.

It is evident at first glance after filtering nutrient solutions, as hay and turnip infusions turbid with bacilli, that the filter restrains the great majority of the minute forms from passing into the earthenware cup with the liquid, as the filtered fluid is always clear and colorless. No interception and reflection of light from the microscopic bits of life is to be noted by the naked eye on examining the filtered